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THE UNIVERSITY OF ALBERTA

PHONETIC AND SEMANTIC SIMILARITY EFFECTS IN A THREE-LIST TRANSFER DESIGN

by

© ANNABEL NESS EVANS

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

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THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

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DEDICATION

TO

Sylvia Ness Evans, my mother

and

Christiaan Evans Lutzer, my son

ABSTRACT

A negative transfer design was used to examine the effects of phonetic similarity under conditions where subjects had previously been encouraged or primed to attend to either phonetic or semantic attributes of words. Three paired-associate lists were learned by all groups. Second, list stimulus items were either phonetically or semantically similar to first list stimuli. In addition, instructions were given prior to each list, to further ensure that subjects were attending to the appropriate dimension.

In the third list, stimulus similarity was varied as were the transfer relationships. A semantically primed group learned a third list where the phonetic dimension was a potential source of interference although continued use of the semantic attribute would provide positive transfer. A phonetically primed group learned a third list where the transfer paradigm was negative with respect to phonetic similarity but positive with respect to semantic similarity.

Third list performance was expected to demonstrate the interference potential of phonetic information under conditions where subjects had been attending to and using this attribute in previous tasks and under conditions where subjects had been using semantic cues to aid acquisition. Also of interest was the effect of relevant semantic cues under conditions where previous lists were phonetically and positively related.

The second list priming manipulations were successful in that positive transfer was evident in the appropriate phonetic and semantic groups. Third list performance, however, indicated little if any phonetic interference in any of the groups. Thus, even in groups where

subjects had been attending to and using phonetic information in previous lists, this dimension failed to provide a reliable source of interference in a subsequent negative transfer list.

A variety of interpretations of the results were discussed. The lack of phonetic interference in any of the groups may indicate that phonetic information is not particularly salient under transfer conditions unless it is primed or emphasized. The loss of a previously successful coding strategy, rather than any direct phonetic interference, may have been responsible for the present results.

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Introduction

When we read a passage about a topic fairly familiar to us, we do not attend to and process every word or even every sentence. Unless we are reading something quite difficult to understand, or unless we are attempting to memorize a written passage, we essentially skip over much of the material. This is due primarily to the redundancy of the language and to the fact that we, as readers, often can deduce from a critical word or two the meaning of a sentence. Essentially then, we read for 'gist' and ignore much of the available, but less important, information. Later, if we are asked to recall the passage, we will remember the meaning or gist of what we read. Rarely will we remember the exact wording involved or grammatical structures. This 'short-cut' allows more rapid and usually more efficient performance.

With single words then, we may expect that what is processed and remembered about a word is its 'gist' or meaning, since words are used primarily to communicate meaning. Unless the context demands attention to other features, it seems reasonable that the meaning of a word should be the critical feature to which we attend in most situations. It is certainly clear that many other features <u>can</u> be attended to, encoded and remembered.

Underwood (1969) has described a variety of features which have proven salient in memory. Some of these include temporality, frequency, orthography, sound and affective tone. The importance of imaginal features, which are a part of meaning, has been demonstrated by Paivio (1971) among others. But, in most, if not all, of these studies, the

subject was in essence 'asked' to pay attention to these attributes. When this is demanded of him, indeed, he is able to comply.

The question of interest is what attributes are necessarily included and functional in the code for words and what attributes can be excluded from that functional code. The answer seems to be that it depends on the task demands, at least in many cases. The simplicity this statement implies, however, is not always supported empirically. The presence of one attribute, in particular, which would at first seem to be relatively unimportant, has been demonstrated to be consistently included and active in word codes. This result occurs even under conditions where its presence provides confusion in learning and remembering. This is the phonetic attribute which includes both the acoustic and the articulatory features of the verbal item. Research has shown that similarity of this attribute interferes with learning. This interference can occur when the items appear to be adequately discriminable on some other dimension.

Of particular interest here is the influence of phonetic similarity under conditions favouring semantic processing, for even under such conditions, phonetic interference has been demonstrated. More specifically, conditions encouraging semantic or phonetic processing of words have been used in an effort to discover the influence of such 'coding sets' in subsequent transfer performance.

The following section consists of a review of the experimental and theoretical work related to phonetic attributes of words and non-words. Several models of word processing are also discussed. The rationale and design of the present study are presented in the final section of the introduction.

Review of the Literature

Early work, primarily concerned with the distinction between short-term and long-term memory, has demonstrated that subjects tend to make "acoustic confusions" in short-term recall of letter sequences (Sperling, 1963; Conrad, 1963). The errors subjects made were related to the correct letters by the similarity in sound of their names (e.g., T for P), even though the letters were presented visually and responses were written. Errors of this type were more frequent than confusions based on similar appearance (e.g., E for F). These findings prompted the hypothesis that coding in short-term memory was acoustic in nature. This notion was strengthened when Conrad (1964) demonstrated a high, positive correlation between type of error made in a short-term memory task and perceptual errors made in the identification of auditorially presented letter names in a noisy background. Subjects tended to make the same kinds of confusions when listening to certain letter names as they did when recalling those letters, although the original presentation was visual. A conclusion common to many of these experiments was that word coding was primarily based on phonetic features in short-term memory while meaning attributes became more important in long-term memory.

The nature of acoustic confusions in short-term memory was studied in more detail by Wickelgren (1965; 1966), with auditory presentation at fast rates. When sequences of consonant-vowel and vowel-consonant digrams were used, the most frequent intrusion errors were for digrams constructed of the same two phonemes in different order (e.g., "pa" for "ap"). Intrusions based on vowel similarities did not depend on the position of the common vowel in two digrams but

consonant similarity was a greater source of error when the shared consonant was in the same position in both digrams. Wickelgren concluded that errors in short-term memory for vowels or consonants are well predicted by a distinctive feature system with three dimensions: voicing, nasality and openness of the vocal tract. Although the data supported the idea of acoustic short-term coding, they were equally compatible with the notion of a speech-motor or articulatory code. In other words, an intrusion may have occurred because that digram sounded like the target item when pronounced, suggesting that coding was based on an acoustic representation. Alternatively, the similarity of the speech mechanisms responsible for pronunciation of both digrams, may have been the source of the intrusion of one for the other.

Hintzman (1965; 1967) reported two experiments aimed at distinguishing between acoustic and articulatory feature coding. Visual presentation was used with immediate recall. The first study used phonetically similar pairs of consonants and digits as stimuli. Errors within and between conceptual classes of materials were systematically based on phonetic similarity. Where two items were not phonetically similar but did share articulatory features, confusions were above chance in frequency, suggesting that at least some articulatory features were encoded. The second experiment was based on the fact that errors made in listening to letter names embedded in noise were consistently correlated with similarity on the dimension of voicing but not with place of articulation. Hintzman assumed that performance on such tasks was based on an acoustic representation of the stimulus. He reasoned that if phonetic confusions in short-term memory are also based on an acoustic code, confusions due to similarity in the

place of articulation dimension should not occur. If articulatory coding is used in short-term memory, however, these errors should occur. Hintzman reported above chance frequency of articulatory confusions and concluded that articulatory coding occurs in short-term memory.

This conclusion was questioned by Wickelgren (1969), who noted that errors based on place of articulation are relatively infrequent on listening tests. He suggested that such errors could be attributed to differential sensitivity to the masking effects of noise between the voicing and place of articulation dimension. This difference in sensitivity to the masking could account for the difference in error patterns between listening tests and Hintzman's short-term memory test where masking noise was not used. Wickelgren concluded that Hintzman's data could be interpreted as supporting the hypothesis that similar codes are used in both paradigms. When subjects vocalize at presentation, however, the addition of white noise increases the number of confusions in recall (Murray, 1965). Moreover, if subjects put out their tongue and closed their teeth on it, preventing articulatory activity, the number of confusions was not greater than when they were permitted activity (Gumenik, 1969). The evidence, then, points both ways.

A further difficulty concerns the definition of articulatory coding. The process may not be peripheral in nature only. The articulatory apparatus itself may not need to be activated. Rather, the central nervous system processes which regulate articulation may be activated without the musculature being affected. Thus, Hintzman's analysis in terms of the place of articulation does not necessarily imply that that place has to be physically activated. It may be the central processes regulating that peripheral activity that are involved

when the subject confuses two letter names having the same place feature. The prevention of muscular articulatory activity is not synonymous with the prevention of articulatory coding; and its failure to increase confusions (Gumenik, 1969) does not necessarily argue against an articulatory hypothesis.

With such conflicting evidence, it seems reasonable to suppose that both acoustic and articulatory coding may be involved. Levy (1971) showed that when overt articulatory coding is prevented, acoustic coding can compensate. Under conditions where all subjects uttered "hi-ya" after each letter was visually presented, subjects who heard the letter name through earphones performed better than subjects who did not. The benefit of hearing the letter name was greater in this case than when subjects pronounced the letter normally and it was concluded that both acoustic and articulatory coding can occur and the loss of one type of information can be compensated for by the use of the other.

Further experiments have demonstrated that recall of acoustically similar items in short-term memory is inferior to recall of acoustically distinct items when ordered recall is required, whereas recall facilitation occurs for acoustically related items in free recall. Baddeley (1966a) found a massive recall decrement in ordered recall of five-word sequences when items were drawn from acoustically similar as opposed to acoustically distinct word pools. He found no such decrement, however, when ten-word lists were recalled after fifteen minutes (Baddeley, 1966b). Baddeley interpreted these studies as implying that acoustic coding is relevant to short-term, but not to long-term retention. In contrast to these ordered recall decrements,

Craik and Levy (1970) found that acoustic similarity enhanced the retrieval of words from the recency positions in free recall.

It is clear that phonetic similarity is salient in short-term memory. The immediate recall method, however, provides little information about the time course of forgetting, and makes it difficult to separate the effects of processes occurring during storage and retrieval.

The time course of short-term forgetting has most frequently been studied with the distractor technique devised by Peterson and Peterson (1959). The distractor technique is characterized by the interpolation of an activity designed to prevent rehearsal between presentation of the to-be-recalled item and the test of recall. This technique was used by Baddeley (1968) in an attempt to compare forgetting rates for phonetically similar and dissimilar words. He used phonetically similar word lists which were shorter in length than the dissimilar control lists in order to equate immediate retention. Forgetting rates over retention intervals between two and sixteen seconds did not differ for similar and dissimilar lists. Another procedure for the investigation of rate of forgetting was devised by Bregman (1968). Subjects viewed a long list of words intermixed with test items consisting of rhymes, graphic cues and conceptual cues for previously-studied target words. Rate of forgetting of these three types of information was similar over retention intervals ranging from three to 288 seconds. In other words, under conditions in which subjects may have soon been aware of the attributes to which to attend, forgetting was similar up to lengthy delays. It seems likely that as soon as a test item was presented, subjects would attend subsequently to the particular attribute that was relevant on that test trial. This

multiple testing procedure then, may provide little information about forgetting of specific word attributes under conditions where subjects are not aware that attention to particular features is advantageous to subsequent performance.

Phonetic similarity has also been investigated with paired-associate techniques. Bruce and Murdock (1968) varied the phonetic similarity between stimuli in a probe paired-associate short-term memory task. Six word-pairs were presented visually at a two second rate, and a retention test was given immediately after presentation of the last pair by presenting one of the stimuli alone. In each list, two pairs had phonetically similar stimuli. There was a marked effect of recency and a significant effect of similarity at the longer retention intervals, but only when the second of the two similar pairs was tested. Thus, phonetic similarity produced proactive but not retroactive interference, a result difficult to interpret with classical associative models which would predict equal interference under such conditions.

Several experiments by Douglas Nelson and his colleagues have demonstrated disruption of acquisition in a paired-associate task when highly meaningful stimuli were phonetically similar. Nelson and Borden (1973) attempted to eliminate phonetic interference by pairing stimuli with associatively compatible responses. An example of such a pair is BANK-VAULT. These conditions failed, however, to eliminate the effect. In a further study, subjects were trained in using stimulus-response interactive imagery (Nelson & Brooks, 1973). With concrete word paired-associates the effect persisted when stimuli were phonetically similar. Although the task directed subjects to encode meaning, the phonetic features continued to interfere. Nelson, Wheeler and

(1976, Exp.I) increased presentation from two or three seconds to five seconds per pair hypothesizing that perhaps the shorter times were not adequate for effective semantic processing. They varied stimulus phonetic similarity, rate of presentation, encoding strategy and associative compatibility of stimulus-response terms. One study-test trial was given, and the test trial was self-paced. While slower rate, compatibility and imaginal encoding all improved performance, phonetic interference was still obtained. The combination of slow rate and imagery instructions did reduce the magnitude of interference, however. Another experiment in the series (Nelson, Wheeler & Brooks, 1976, Exp.IV) again varied similarity with instructions to use either sentence mediation or interactive imagery. The slow rate of presentation (five seconds) was used and under these conditions, phonetic interference was eliminated.

The effects of phonetic similarity in long-term memory have not been studied extensively, but the available results appear consistent. Dallett (1966) reported four experiments investigating the effects of stimulus similarity in acquisition and retention of paired-associate lists after one week. Similarity was varied both within and between lists. Although between-list similarity had little effect, within-list similarity retarded acquisition and depressed long-term retention. Bruce and Murdock (1968, Exp.II) examined long-term memory for paired-associates in an RI design. Again, phonetic similarity between stimulus lists affected neither acquisition nor retention. McGlaughlin and Dale (1971), however, reported significant facilitation in transfer due to phonetic similarity of stimulus terms.

Wickens, Ory and Graf (1970) reported two experiments (Exp.V and VI)

dealing with response similarity in transfer. They reported negative transfer due to phonetic similarity of responses. They did not obtain positive transfer in their experiments. Laurence (1970), however, did report significant effects of phonetic response similarity in both the negative and positive transfer paradigms. Clearly, phonetic attributes can be represented in long-term memory, but the boundary conditions underlying their representation are still unknown.

The phonetic dimension is a potent one under many learning and remembering conditions. Nelson's work, among others, seems to suggest that these attributes are accessed along with meaning. Although semantic encoding strategies can aid in learning, phonetic features are activated and may influence performance.

These findings are compatible with several theoretical models of word coding. A multiple feature view (Bower, 1967; Wickens, 1970; 1972; Underwood, 1969) would hold that a variety of physical and phonetic features are processed along with meaning. Many words share some features, but the combination of features is what produces a discriminable code for each word. As similarity between encoded attributes increases, the potential for confusion also increases. This confusion may result from failure to encode sufficient information during learning to allow discrimination between codes. Confusion may also result, however, from forgetting of the one or more features which did provide discrimination at the outset. In either case, the nominal stimulus may contact the code for more than one item, the result of which may be interference.

Certainly, the levels of processing approach (Craik & Lockhart, 1972) provides a possible explanation for phonetic interference among

semantically discriminable stimuli. This model assumes that words are processed from more superficial levels requiring analysis of physical and phonetic features to deeper levels requiring semantic analysis. Given that semantic processing follows phonetic processing in sequential order, then phonetic information may be present in the more elaborate code, regardless of the effectiveness of semantic coding. This view would assume that as long as phonetic attributes are activated, as they must be in order for more elaborate coding to occur, then they may have the potential to interfere at test.

An alternative model has been described by Nelson (1978). This model deals with word and picture processing. Several assumptions involving the encoding and the retrieval stage of learning and remembering are described. The encoding stage involves four of these. First, it is assumed that three types of attributes can be encoded both with picture and word stimuli: visual, phonetic and semantic. The second assumption deals with the order of activation of these attributes. Pictures are assumed to require some semantic processing before phonetic processing can occur. A picture cannot be appropriately labeled until it is recognized by the viewer. When words are processed, however, phonetic access is direct; and semantic processing does not have to be initiated before phonetic coding can begin. Further, semantic analysis may be achieved directly from the physical stimulus as well as after some phonetic processing has occurred. Nelson suggests, however, that in tasks involving single words, some phonetic processing occurs prior to semantic analysis. The third assumption involves encoding sets or priming manipulations. It is assumed that task demands, including the nature of the learning material itself or

instructions by the experimenter, can direct the learner's attention and processing to specific attributes. This focusing of subjects' attention on a specific feature, however, does not eliminate processing of other kinds of information which then can be included in the code. If the learner is directed toward processing semantic information, visual and phonetic attributes may be activated as well. This has been supported empirically by Nelson (Nelson, Wheeler & Brooks, 1976) and by Runquist (1978). In addition, the model assumes that when processing is directed toward phonetic/visual processing, semantic information may also be encoded. The final encoding assumption concerns similarity among processed features and discriminative coding. The distinctiveness of the code is assumed to determine performance. Any attributes shared by items which are also processed will serve to reduce the distinctiveness of their codes and thus hinder learning and retention. Meaning is assumed to provide, for the most part, more distinctive word codes; therefore, meaning coding will generally facilitate performance.

The second stage of the model involves retrieval which is assumed to be reconstructive. The retrieval cue serves to regenerate the target item. As the attributes of the retrieval cue become more similar to those activated by the target during study, the higher is the probability that the target will be recalled.

Although Nelson's model suggests that meaning will usually provide a unique and thus, superior code, this is not to suggest that phonetic features are transient or trivial components in word codes. Experiments abound--several have been discussed previously--which demonstrate the potency of phonetic similarity, even when meaning provides discriminability

between items.

The experiments reported by Nelson and his colleagues (1973; 1976) demonstrating a persistence of phonetic interference in acquisition with semantically discriminable materials, provide support for the notion that phonetic information is included and used even in codes for highly meaningful stimuli, in a relatively automatic fashion. Some support for this notion was provided by Evans (1974, Exp.II) when subjects who were encouraged to attend to meaning attributes of stimuli, nevertheless suffered phonetic interference during acquisition in a paired-associate negative transfer design. These subjects could have avoided interference simply by "ignoring" the redundant phonetic dimension. This study did not, however, provide unequivocal support because of the lack of strong positive transfer in the semantic dimension.

Rationale

Is the phonetic dimension "usually" attended to, and, further, is it an obligatory feature in the functional code for words? Nelson's work suggests that it is. However, it may be suggested that his task 'demanded' encoding of that feature, not in the traditional way, but by increasing its salience simply through the abundance of similarity that was present among his stimulus terms. Nelson and his colleagues used paired-associate stimuli which were similar within a list. Under these conditions, phonetic processing may well be primed since subjects may have been encouraged to notice the similarity simply because its presence was clearly obvious. Perhaps coding of semantic features is dominant in word processing, and phonetic information is relatively unimportant, unless task conditions increase its salience.

The present experiment was designed in an attempt to investigate

the influence of the phonetic dimension under conditions where attention to semantic features of words was encouraged. When stimulus items have clearly differentiable meanings, and when those stimuli never themselves have to be recalled, is phonetic information necessarily included in the codes for those words? And if it is included, does it produce interference in learning when semantically different stimuli are phonetically similar? This study was directed toward examining these issues under learning conditions in which semantic processing was encouraged.

An additional concern involved the role of word meaning under conditions where attention to the phonetic dimension was previously encouraged. Does meaning lose salience under such conditions or is this information encoded and used along with phonetic information?

In an attempt to avoid the possibility of priming encoding of a specific attribute simply through its redundancy, a paired-associate transfer design was selected. Such a design permits the manipulation of stimulus similarity across rather than within lists. The use of three lists provided the opportunity for encouraging subjects to attend to a particular attribute during second list acquisition by utilizing a positive transfer paradigm. In addition, verbal instruction to attend to a particular dimension was employed.

In the phonetically primed groups, second list stimuli were phonetically similar to, and their responses were identical with, the stimuli and responses of the first list. In the semantic priming groups, the second list conformed to a positive transfer paradigm with respect to semantic similarity. All groups, then, were presented with a third list. Stimulus similarity was varied as were the transfer

relationships, either positive or negative.

One of the semantic priming and one of the phonetic priming groups learned a third list under conditions of positive transfer with respect to semantic similarity and negative transfer with respect to phonetic similarity. Performance of the semantically primed group was expected to demonstrate the capacity of phonetic similarity to interfere with the processing and/or use of semantic information when a previous set to attend to such information had been established. Performance on this list of the phonetic priming group, on the other hand, was expected to demonstrate the potential of relevant semantic information to reduce phonetic interference, when a set to encode phonetically had been previously established.

The present study, then, attempted to establish in subjects coding sets to attend to specific features of words. Once these sets were established, the question of interest involved the role of the previously non-emphasized or non-primed attributes under conditions in which they became potentially relevant cues.

Method

Transfer Relationships

Semantic processing was encouraged in two of seven groups by making List 2 stimuli similar in meaning to first list stimuli. Phonetic coding was encouraged in three groups by using a second list where stimuli were phonetically similar (i.e., rhymed with) to those in List 1. List 2 responses for these groups were identical with those used in List 1. These relationships produced A-B, A'-B transfer paradigms for all the above groups.

Subjects in two additional control groups learned A-B, C-B lists where A and C stimuli were not systematically related with respect to semantic and phonetic attributes.

Of the two semantic coding groups, one learned a third list where stimuli were similar, and responses were identical, to those in previous lists. This group was included to provide a baseline for positive transfer in the semantic dimension. The second semantic group was treated identically with respect to semantic relationships in List 3, however, phonetic stimulus similarity was introduced as well. In this group, third list stimuli were phonetically similar to List 2 stimuli, but responses were re-paired. For example, if one of the stimuli in List 2 was "grime", then its semantic counterpart in List 3 might be "dirt" paired with the same response. In addition, however, another stimulus word which rhymed with "grime" (e.g., "time") would be present in the third list and paired with some other response. For this condition, then, the transfer relationship between third and second list items was

positive with respect to semantic similarity (A-B, A'-B) and negative with respect to phonetic similarity (A-B, A'-Br), and these two relationships were produced simultaneously. This group was expected to demonstrate the capacity of phonetically similar and re-paired stimuli to interfere with semantic processing or the use of semantic information when a previous set to attend to semantic features had been established. If phonetic features had not been attended to or minimally processed during List 2, then, this group should perform as well as the group where phonetic similarity was not present in List 3.

A third list negative transfer relationship with respect to phonetic similarity was produced in two of the phonetic coding groups by using stimuli which were similar to previous list stimuli, and by re-pairing identical responses. In one of these two groups, third list stimuli were also semantically similar to second list stimuli, and their responses were identical. This group was included to examine the influence of a positive semantic relationship between stimuli under phonetic interference conditions when a set to attend to phonetic features had been established. For example, if semantic information about second list stimuli had not been processed or had been minimally attended to, then, this group should perform as poorly on List 3 as a group where semantic transfer was not possible. Alternatively, if meaning is always attended to when words are stimuli, this group may be able to use the positive relationship to avoid or at least reduce interference.

The remaining phonetic coding group learned a third list where no systematic inter-list phonetic similarity between stimuli was present, but the presence of a positive transfer relationship with respect to semantic similarity was expected to demonstrate potential semantic

transfer in a group previously encouraged to attend to phonetic features. If semantic information was not processed previously, this group conformed to an A-B, C-B paradigm with respect to the second and third list transfer relationship.

One of the two groups, where no particular attribute was primed during List 2 acquisition, learned a third list where stimulus relationships were negative with respect to phonetic similarity, and the other group learned a third list where stimuli were not obviously related to previous list stimuli. The former was included to provide a baseline for phonetic interference without previous priming to attend to specific features, and the latter provided a measure of non-specific transfer across three lists.

Stimulus Materials

Two sets of seven twelve-item lists of common words were constructed to provide one complete replication of the seven group design. These are presented in Appendix A. With the exception of the lists numbered 1A, 1B, 2A and 7A, all items were single syllable words. Each set of lists was constructed in the following manner.

A twelve-item list of unrelated words of varying lengths was formed (List 1). Two additional twelve-item lists, each composed of one synonym to each of the twelve original words, were formed with the aid of Roget's Pocket Thesaurus (1946) (Lists 2 and 3). A fourth list was constructed by generating a third word similar in meaning to each item in List 3 with the constraint that each new synonym word must also rhyme with another word; not its synonym, in that list (List 4). In addition, two rhymes were generated to each item in List 3, producing Lists 5 and 6. A seventh list was constructed in a similar fashion using one rhyme

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for each of the items in List 2. This entire procedure was repeated with twelve new unrelated words to produce the second set (B) of lists. An attempt was made to use common words, although this became somewhat more difficult for Lists 6 and 7. Responses were the numbers from one to twelve and were assigned randomly to List 1 stimuli.

Due to the constraints of the design the stimulus materials were not equated on any of the attributes typically discussed in the literature, such as frequency, imagery value, etc. Attempts were made to use common words but this was not always possible. Attempts were also made to avoid phonetic and semantic similarity within lists but again, this was unavoidable in some cases. Semantic relationships between stimulus items varied considerably in magnitude, particularly in the few cases where a word may have had more than one meaning. These difficulties in list construction were a result of the requirements of the design and any effects attributable to the words used expected to reduce transfer rather than inflate such effects.

Design

The names for conditions were assigned by describing the type of stimulus similarity between lists: either semantic (S), phonetic (P) or unrelated (U), the transfer list involved: either first or second, and the paradigm: either positive, negative or zero. Table 1 presents the transfer paradigms used and an example pair for each. The superscripts and subscripts refer to the nature of the stimulus similarity: either semantic (s) or phonetic (p).

For example, the group named S-SPr learned its second list (List 2) under positive transfer conditions using semantic similarity, hence the first "S" in its name. The second transfer list which is List 3, involved

both semantic and phonetic similarity, hence the "SP". The phonetic relationship, however, was achieved through re-pairing responses, hence "Pr". The S-S group, on the other hand, learned two transfer lists (Lists 2 and 3), both of which involved semantic similarity with no re-pairing and thus conformed in both cases to a positive transfer paradigm.

The final transfer list was identical for all conditions within each list set. The two semantic, and the three phonetic conditions conformed to a positive transfer design in List 2 since stimuli were similar, and responses were identical to those in the first list. Both control groups (U-Pr) and (U-U) provide baseline performance in List 2, since no specific transfer relationships were present.

In List 3, the P-Pr and the U-Pr groups conformed to a negative transfer paradigm, since stimuli were highly similar to List 2 stimuli, and responses were re-paired. Third list stimuli for the S-S and P-S groups were similar to second list stimuli, and responses were identical, producing a positive transfer relationship for both groups. For the S-SPr and P-SPr groups, two transfer relationships were present between Lists 3 and 2. A positive transfer situation was present with respect to semantic similarity, and a negative relationship was present with respect to phonetic similarity.

Subjects

Subjects were drawn from introductory psychology courses and received financial payment or course credit for participating in the experiment. Twenty subjects were assigned to each condition with ten subjects in each group within each set of stimulus materials. Subjects were assigned to conditions as they entered the laboratory according to

Table 1. Experimental Design.[1]

ATTRIBUTE PRIMED	CONDITION NAME	FIRST LIST	SECOND LIST	THIRD LIST
SEMANTIC	S-SPr	A-B (1) filth - 1 injure - 2	A'^{S}-B (3) dirt - 1 harm - 2	A''^{S}-$_{'p}$B Br (4) grime - 1 hurt - 2
	S-S	A-B (1) filth - 1 injure - 2	A'^{S}-B (2) soil - 1 wound - 2	A''^{S}-B (4) grime - 1 hurt - 2
PHONETIC	P-S	A-B (7) boil - 1 tuned - 2	A'^{P}-B (2) soil - 1 wound - 2	A'^{S}-B (4) grime - 1 hurt - 2
	P-SPr	A-B (5) shirt - 1 charm - 2	A'^{P}-B (3) dirt - 1 harm - 2	A'^{S}-$_{''p}$B Br (4) grime - 1 hurt - 2
	P-Pr	A-B (5) shirt - 1 charm - 2	A'^{P}-B (6) flirt - 1 arm - 2	A'^{P}-Br (4) grime - 1 hurt - 2
NONE	U-Pr	C-B (6B) (6A) skiff - 1 rent - 2	A-B (5B) (5A) shirt - 1 charm - 2	A'^{P}-Br (4B) (4A) grime - 1 hurt - 2
	U-U	C-B (1B) (1A) rock - 1 smell - 2	D-B (6B) (6A) skiff - 1 rent - 2	A-B (4B) (4A) grime - 1 hurt - 2

[1]Numbers in parentheses refer to actual lists used as labeled in Appendix A. Superscripts and subscripts refer to dimension of similarity. An example pair is provided for each paradigm.

a scheme which randomized conditions within blocks containing each condition once.

A total of 90 female and 50 male subjects were run. Within conditions the numbers of males ranged from six to ten, and the number of females ranged from eleven to fifteen.

Procedure

Subjects were tested individually and learned three consecutive quasi-PA lists. Stimuli were presented visually and one at a time for two seconds each, during which time subjects were required to respond with a digit from one to twelve. This was followed by a blank space for two seconds, during which time the experimenter indicated verbally whether or not the response was correct. The inter-trial interval was two seconds. Since the responses per se were never presented, subjects were instructed to guess on initial trials. This procedure was adapted from Goggin and Martin (1970).

Learning on all lists continued to a criterion of three errorless trials. A total of 58 subjects were discarded. Twenty-seven were discarded for failing to reach criterion on List 1 in less than 49 trials. The remaining 31 were discarded due to experimenter error or apparatus failure. These discards were not differential between conditions.

Subjects in the semantic conditions (S-S and S-SPr) were informed prior to each list as to the relationship between stimuli. They were further instructed to attend to the meanings of the words during learning.

Subjects in the phonetic conditions (P-SPr, P-Pr and P-S) were similarly informed about the stimulus relationships prior to first and second list learning, but were not told about the relaitonship of the third list to previous lists.

Subjects in the U-Pr and U-U conditions were given standard PA instructions modified such that the inter-list intervals were approximately equal to those in the other conditions and modified to suit the task. The instructions are presented in Appendix B.

Results

Lists (first, second and third learned) were analyzed separately and two analyses were performed on each list. The list and treatment condition relationships differed for each list due to the constraints involved in producing the transfer paradigms.

For the first learned list, the lists from each list set were neither crossed with nor nested in treatment conditions. For this reason, the data were collapsed across list set for each treatment condition. The phonetic coding conditions with the control groups were then analyzed using an analysis of variance for a randomized group design with five treatment conditions (P-S, P-Pr, P-SPr, U-U, U-Pr) and twenty subjects per condition. The semantic coding conditions with the same control groups (S-S, S-SPr, U-U, U-Pr) were subjected to an analysis of variance for a randomized group design.

For the second learned list, lists were nested within treatment conditions. The phonetic conditions and controls were therefore analyzed with an analysis of variance for a nested design where both treatment conditions and lists (within treatments) were tested with the subjects (within lists and treatments) as the error term. The same analysis was used for the semantic conditions and the controls.

The third learned lists were completely crossed with treatment conditions and therefore the phonetic and semantic conditions were separately analyzed with a 5 x 2 and a 4 x 2 factorial analysis of variance, respectively, with lists (set A and B) and treatment conditions as between subject factors.

Mean total errors was the primary dependent measure. Mean trials

to criterion, and mean errors on the first three trials, were also analyzed and are presented in Appendix C. Trial by trial performance on the final list was examined by plotting trials to successive criteria for each group. Inspection of these learning curves revealed no additional information.

Phonetic Conditions

List 1. The means and variance estimates for each list set are presented in Table 2. No reliable differences between conditions ($F(4,95)=0.55$, $p>.05$) in first list performance were obtained, indicating that these groups were comparable. Inspection of each list set did not reveal any consistent differences in mean performance.

List 2. The mean and variance estimates for each list set are presented in Table 3. Examination of the means indicates superior performance of the phonetic conditions over the control groups, and the statistical analyses supported this trend. Significant main effects were due to conditions ($F(4,90)=43.04$, $p<.01$).

Analyses of mean trials to criterion and mean errors on the first three trials indicated that performance was superior for subjects in List Set B but this difference was not reliable with the primary dependent measure.

The data were collapsed over list sets and subjected to Duncan's Multiple Range Test. This analysis revealed that the three phonetic conditions were superior ($p<.01$) to the two control groups. The obtained positive transfer indicated that subjects were attending to and using the phonetic dimension.

List 3. The means and variance estimates for each list set are presented in Table 4. The slight differences between the means were

Table 2. Mean Total Errors by List Set and Condition on List 1.

CONDITION	LIST SET A		LIST SET B		MEAN TOTALS
	MEAN	(S.E.)	MEAN	(S.E.)	
P-S	190.2	(15.9)	162.8	(20.1)	176.5
P-Pr	160.6	(13.3)	168.8	(14.6)	164.7
P-SPr	176.2	(11.1)	193.4	(23.8)	184.8
U-U	152.3	(17.1)	181.9	(17.6)	167.1
U-Pr	183.2	(15.2)	181.5	(20.1)	182.4

Table 3. Mean Total Errors by List Set and Condition on List 2.

CONDITION	LIST SET A		LIST SET B		MEAN TOTALS
	MEAN	(S.E.)	MEAN	(S.E.)	
P-S	28.8	(4.0)	15.2	(5.6)	22.0
P-Pr	28.2	(2.7)	18.4	(7.3)	23.3
P-SPr	20.3	(2.7)	37.9	(8.9)	33.1
U-U	97.6	(7.8)	82.5	(10.0)	90.0
U-Pr	114.7	(16.2)	79.1	(5.6)	96.9

Table 4. Mean Total Errors by List Set and Condition on List 3.

CONDITION	LIST SET A		LIST SET B		MEAN TOTALS
	MEAN	(S.E.)	MEAN	(S.E.)	
P-S	106.7	(13.2)	96.3	(10.9)	101.5
P-Pr	106.1	(11.4)	113.5	(21.8)	109.8
P-SPr	137.6	(20.3)	108.9	(9.0)	123.2
U-U	82.9	(10.1)	102.6	(15.0)	92.8
U-Pr	89.6	(12.9)	91.9	(5.4)	90.8

not reliable. No significant differences, due to conditions ($F(4,90)=1.86$, $p>.05$) or lists ($F(1,90)=0.06$, $p>.05$), were obtained. The interaction was not significant ($F(4,90)=0.89$, $p>.05$).

Although negative transfer was expected in the P-Pr and the U-Pr groups, it was not obtained. When the data were collapsed across list sets, and subjected to Duncan's Multiple Range Test, only the performance of the P-SPr was significantly inferior ($p<.05$) to that of the control groups.

Semantic Conditions

List 1. The means and variance estimates for each list set are presented in Table 5. Inspection of the means reveals little difference between groups, and this was borne out by the statistical analyses. No reliable differences between conditions ($F(3,76)=0.56$, $p>.05$) were obtained, indicating that performance on the initial lists was comparable.

List 2. The means and variance estimates for each list set are presented in Table 6. The apparent superiority in performance of the semantic conditions was supported by the analyses. A significant difference between conditions was obtained ($F(3,72)=29.02$, $p<.01$). A significant difference between lists ($F(4,72)=2.67$, $p<.05$) appeared to be due to the superiority of both control groups in List Set B, over their counterparts in Set A.

The positive transfer evidenced in the semantic groups indicated that subjects in these conditions were using semantic information to aid in learning. Duncan's Multiple Range Test of the collapsed data indicated that the S-SPr and S-S groups were superior ($<.01$) to the two control groups.

List 3. The means and variance estimates for each replication are

Table 5. Mean Total Errors by List Set and Condition on List 1.

CONDITION	LIST SET A		B		MEAN TOTALS
	MEAN	(S.E.)	MEAN	(S.E.)	
S-SPr	164.1	(17.2)	169.8	(15.9)	166.9
S-S	190.8	(17.2)	173.7	(14.8)	182.3
U-U	152.3	(17.1)	181.9	(17.6)	167.1
U-Pr	183.2	(15.2)	181.5	(20.1)	182.4

Table 6. Mean Total Errors by List Set and Condition on List 2.

CONDITION	LIST SET A		LIST SET B		MEAN TOTALS
	MEAN	(S.E.)	MEAN	(S.E.)	
S-SPr	21.2	(5.2)	37.7	(7.7)	29.5
S-S	37.2	(8.2)	39.6	(7.3)	38.4
U-U	97.6	(7.8)	82.5	(10.0)	90.1
U-Pr	114.7	(16.2)	79.1	(5.6)	96.9

presented in Table 7. Inspection of the means reveals a clear superiority in performance of the semantic groups. Statistical analysis confirmed this apparent difference. Main effects were due to conditions ($F(3,72)=66.57$, $p<.01$). A significant main effect due to lists was not obtained with the primary performance measure, mean total errors, but was obtained on the two secondary measures. The F values for the mean trials to criterion measure and the errors on the first three trials measure were 4.19, $p<.05$, and 11.15, $p<.01$, respectively, with 3 and 72 degrees of freedom.

The analysis revealed no significant interaction between lists and conditions ($F(3,72)=0.43$, $p>.05$), and the mean total error data were then collapsed over list sets. Duncan's Multiple Range Test of these data indicated that the S-SPr and S-S groups were superior to the two control conditions ($p<.01$). The equivalence of the semantic groups indicated that the re-pairing of responses in the phonetic dimension (S-SPr) failed to interfere with acquisition performance.

Substitutions in List 3 of responses, which were previously correct for the phonetically similar stimuli in List 2, were recorded as phonetic intrusions. The occurrence of phonetic intrusions was infrequent in all groups, and no differences between groups were apparent.

Table 7. Mean Total Errors by List Set and Condition on List 3.

CONDITION	LIST SET A		LIST SET B		MEAN TOTALS
	MEAN	(S.E.)	MEAN	(S.E.)	
S-SPr	3.9	(1.8)	13.3	(3.9)	8.6
S-S	6.3	(2.2)	10.8	(2.7)	8.6
U-U	82.9	(10.1)	102.6	(15.0)	92.8
U-Pr	89.6	(12.9)	91.9	(5.4)	90.8

Discussion

The results of the present experiment are discussed in the first section of this chapter. The second section presents a brief discussion of the most prevalent theory of specific transfer. Several alternative interpretations of the present results are offered in the final portion of the discussion section.

Discussion of Results

Phonetic Conditions. Positive transfer in second list performance was obtained in the phonetic groups, as was expected, since these groups conformed to an A-B, A-B' transfer paradigm on this list. The magnitude of transfer was essentially equal within List Set A. Within Set B, however, the P-SPr group did not show as much transfer as the other phonetic conditions. Second list performance differed somewhat between lists and inspection revealed that performance of subjects in the second set of lists (B) was superior for all groups except P-SPr. Since both subjects and lists differed it is not possible to distinguish between list or group differences in terms of this effect.

The capacity of stimulus phonetic similarity to produce positive transfer has also been demonstrated by McGlaughlin and Dale (1971). This result in the present experiment was assumed to demonstrate that subjects were using phonetic information and associations from the first list to aid in acquisition of the second list.

Third list performance of the phonetic groups was similar although the P-SPr group was found to be worse than the control groups but not statistically different from the P-S and P-Pr groups. It should be

noted that the P-SPr group did not show as much positive transfer on List 2 as did the other phonetic groups. It was expected that the P-Pr group would perform more poorly on this list if subjects in the other two groups were able to use semantic information to aid in acquisition. The P-S group did not conform to a negative transfer paradigm; in fact, had semantic information been used, this group should have demonstrated positive transfer in third list performance. On the other hand, the transfer relationship between the second and third lists was A-B, C-B, had meaning not been attended to during second list learning. Nevertheless, subjects in this group performed as poorly as those in the negative transfer groups.

The lack of statistical difference between the control group and the negative transfer groups precludes any unequivocal conclusions, although there was a trend toward inferior performance in the experimental conditions. This result may be interpreted as indicating that subjects in the P-S and P-SPr groups failed to use the relevant semantic information to facilitate transfer performance. It indicates also, however, that subjects in the P-Pr and P-SPr groups apparently did not continue to use phonetic features as cues, since their performance was not reliably different from that of the control group. Instead, it appeared that subjects simply treated this third list as if it were unrelated to previous lists. The P-SPr data in conjunction with the lack of difference between the U-U and U-Pr groups, may indicate that phonetic information is not usually used unless previously primed.

Semantic Conditions. Second list positive transfer was obtained, as expected, in the S-S and S-SPr groups. This effect was considered to be a potent one since the semantic relationships between stimuli did

not always appear to be very strong due to the constraints of the design on stimulus selection. A difference in performance of the U-U and U-Pr groups between list sets was apparent, producing the significant difference between lists. The S-SPr group in list set A, however, showed greater positive transfer than the other groups which were very similar. This result may indicate differential list difficulty since performance was not different between groups on List 1.

Positive transfer was clearly evident in both semantic groups in third list performance. It was predicted that the S-SPr group would perform less well than the S-S group on this list if phonetic information had been processed and used during third list acquisition. This prediction was based on the assumption that the phonetic information would produce interference since the third list responses were re-paired with respect to phonetic similarity. The predicted difference was not obtained, however. Subjects in this group showed as much positive transfer as did those in the S-S group where the phonetic dimension did not provide a potential source of interference.

Although Nelson's (1973, 1976) studies have indicated that phonetic similarity is a persistent source of interference in paired-associate learning with meaningful materials, the present results indicate that this dimension is not a potent source of interference, at least under some conditions. It seems that the phonetic dimension is not particularly salient under conditions of negative transfer, as employed in the present study. Perhaps the phonetic dimension must be continually emphasized in some ways before it plays a significant role in acquisition. Nelson's experiments used a within-list design in which the presence of similarity may have been clearly evident. Under such conditions,

subjects apparently encode and use these attributes even though they are redundant and, as a consequence, interference occurs. The results of the present experiment provided little, if any, evidence for interference due to phonetic similarity even when that dimension had been emphasized previously. Although positive transfer occurred when stimuli were phonetically similar significant negative transfer in a re-pairing did not occur.

Two results of the present experiment were very clear. First, phonetic similarity did not produce interference regardless of the previous priming conditions. Second, semantic positive transfer did not occur when subjects were encouraged to use the phonetic dimension in previous list acquisition. The following section briefly describes some of the basic principles and hypotheses of transfer which underlie interpretation of the present results.

Transfer Theory

A variety of models and hypotheses and models regarding transfer have been described in the verbal learning and memory literature. One of the most widely accepted theories assumes a mediational type of process underlying transfer (Gibson, 1940; Underwood & Schulz, 1960). A nominal stimulus item in the transfer list is assumed to evoke a similar previous list stimulus which, in turn, activates its associated response. When the response associated with the transfer list stimulus is identical to the response associated with the similar stimulus, positive transfer occurs. Learning is faster under these conditions because associative learning is minimized. Thus, the subject mediates from the new stimulus through its similar stimulus to the previously associated response.

If, on the other hand, the similar stimuli require dissimilar responses, this mediational process will result in the evocation of an incorrect response. Assuming this mediational process to be relatively difficult to inhibit, interference in acquisition of the transfer list will occur. The re-pairing paradigm, A-B, A-Br, is considered to produce maximum negative transfer (Dallett, 1965). Presumably, under these conditions, response competition (McGeough, 1931) is very strong and suppression of the first list responses (Postman, Stark & Fraser, 1968) is not possible.

Underwood and Schulz (1960) described a two-stage model of transfer which conceived of response learning and associative learning to be separate components which can be transferred from one task to another. Response learning was assumed to transfer positively from first to second list if second list responses were identical to or similar to first list responses. Associative learning involved both forward (A-B) and backward (B-A) associations. For forward associations, the amount of transfer is assumed to be an increasing function of the degree of stimulus similarity whereas, the effect of backward associations is determined by similarity between response terms. Each of the several transfer paradigms then can be described in terms of the potential for transfer of response and associative learning. These two components, although perhaps the most important, do not exhaust all the potential factors involved in transfer.

Transfer, then, is seen as involving a mediational process. The occurrence of transfer in acquisition provides information about what information was encoded during first list learning. A transfer list stimulus item can only evoke a previous list stimulus if some of the

same attributes were processed when the two items were coded. If these common attributes were used in the first list association, then transfer in second list performance may occur. These assumptions provide the basis for a viable interpretation of the present data. This interpretation, along with several alternatives, is presented in the next section. These must be considered largely speculative since direct tests of their underlying hypotheses were not provided by the present study.

Interpretation of Present Results

The mediational theory of transfer, which assumes that subjects mediate from one stimulus to another when those stimuli are similar in some way, provides a potentially valuable interpretation for the data presented here. This interpretation requires, however, that the mediational process be considered a "strategy" under the control of the subject. The term "strategy" is used here to refer to a process elected by the subject as described by several theorists (e.g., Atkinson & Shiffrin, 1971). For five of the groups in the present study, mediation during second list learning would have been successful, i.e., the strategy of mediating would produce positive transfer. The three phonetic and two semantic conditions all learned second lists where mediation from those stimuli to the similar previous list stimuli would have produced correct associated responses. On the third list, continued mediation on the same dimension of similarity would have been successful for only two of those groups. For both semantic groups, mediation through word meaning would have resulted in positive transfer, and, indeed, these groups performed very well on this list.

In two of the three phonetic groups (P-Pr, P-SPr), continued mediation through rhyme would have led to incorrect responses and,

therefore, was not a successful strategy. It might be expected that if a mediational strategy persisted in these two groups, their performance would be inferior to that of the control groups. These two groups, however, were not significantly inferior in third list performance to groups where re-pairing was not present. Rather, their performance was similar to that of a group where mediation through rhyme was not possible but mediation through meaning would have provided positive transfer (i.e., P-S). These results, in conjunction with the fact that the P-S group did not show any positive transfer, might suggest that the loss of a previously successful 'strategy' hindered acquisition rather than any direct phonetic interference.

The assumption here is that subjects quickly discovered that mediation was not useful and thus, simply stopped mediating and treated the list as if it were unrelated to previous lists. Their performance was very similar to a group where this was, in fact, the case. This interpretation does not require any assumptions about the obligatory nature of phonetic processing. The assumption is that mediation is abandoned, but phonetic coding may or may not continue. In other words, phonetic attributes may continue to be activated but their activation does not arouse the similar rhyming item.

An alternative interpretation might assume that the phonetic dimension is not a very salient one in word processing. Unless task conditions are such that its salience is increased, attention to phonetic information might be expected to be infrequent in most learning conditions. The literature on this point is somewhat confusing. Positive transfer with phonetic similarity but with no specific instructions to attend to that dimension has been demonstrated (e.g., Evans, 1974;

Nelson, Davis, 1972, Exp.II) but reports of minimal or no facilitation can also be found (e.g., Wickens, et al., 1970; Nelson & Davis, 1972, Exp.I). This interpretation assumes that phonetic information can be used, under the appropriate conditions, but that its influence in transfer is somewhat limited. When task conditions permit coding on some other dimension such as meaning, then phonetic similarity has little effect under negative transfer conditions.

Craik and Lockhart (1972) argued that incoming stimuli are subjected to a series of analyses, starting with 'shallow' sensory analyses and proceeding to 'deeper' analyses of a more elaborate and semantic nature. For such a notion to be consistent with the present results, it would be necessary to assume that once the deeper semantic analyses have occurred, the information gained from the shallower analyses is secondary in some way to the semantic analysis. When task conditions prime the importance of the shallow analysis, however, then this information may be used to facilitate performance but it does not provide a source of interference.

With respect to the attribute theory of word processing, the present results do not support the assumption that a word is processed as a bundle of features all active components of the code. That a word may be processed this way when demanded by the task is clear. An efficient verbal system would be expected to work only as hard as necessary to achieve its goal. In most learning and remembering situations, the goal is to learn and remember meaning or ideas. This research implies that in the learning of paired-associates at least, learning and remembering meaning is not easily disrupted. Other features can be used when they are helpful in performing the task but their role

is of minimal importance when they are not relevant to improved performance. Such a suggestion must be qualified by the statement that some situations at least seem to increase the salience of other features, even though they provide no aid to performance. Such situations seem to involve the case in which the redundancy of the attribute is exceptionally evident and in these cases confusion abounds.

It seems reasonable that, as in reading, subjects, when attempting to link up a response with a single word, concentrate on the 'gist' or idea inherent in the stimulus item. Phonetic att ributes appear ancillary to this goal and need not come into play unless they are necessary for inter-item discrimination or unless task demands otherwise encourage their use. The phonetic conditions in the present study increased the importance of this attribute by making attention to phonetic features necessary for positive transfer. When phonetic features no longer were relevant to positive transfer, they appeared to lose their salience. As a result, little if any interference was seen. It was apparent, however, that when the phonetic attribute was emphasized, attention to and use of word meaning was affected. Subjects in the P-S group, where attention to and use of semantic information during second and third list learning could have provided positive transfer, did no better than control groups where such transfer was not possible. Therefore, although word meaning may be the preferred attribute, when the phonetic dimension is primed the semantic dimension may lose its potency. Several other studies have demonstrated the importance of type of processing strategy, whether subject selected or experimenter selected. Tulving's work (1973), for example, has alerted us to the fact that an actual 'identical' target word may not be recognized as

such under certain conditions. This demonstration was achieved by emphasizing a particular meaning of a word by presenting it with another word which, in essence, biased its processing. Later, when that 'same' word was presented for recognition in a different context, subjects failed to recognize it. Presumably, this result occurred because the test item was not the same as the original in terms of the functional code it generated at test.

The research presented here has shown that phonetic similarity is not always a persistent source of interference in learning. Even in cases where subjects were previously attending to and using phonetic information to facilitate learning, this dimension did not produce negative transfer in a subsequent re-pairing paradigm. In addition, relevant semantic information did not improve the performance of subjects previously primed to code phonetically.

Since several of the findings were unexpected, many questions can be posed. One of the possible interpretations of these data suggested that loss of a previously successful strategy produced the effects in third list performance. When that strategy no longer aided learning, subjects may have simply abandoned it and treated the new list as if it were unrelated to previous lists. Such an interpretation appears reasonable and deserves further investigation. If semantic processing is assumed to be preferred and more efficient, however, as suggested by several theorists (e.g., Craik & Lockhart, 1972), then a question of interest concerns the ease by which subjects could abandon that way of processing words under conditions where it no longer facilitated performance. A negative transfer semantic group with some other dimension relevant would determine whether semantic information can be

as easily 'ignored' as phonetic information appeared to be.

In conclusion, positive transfer with semantic similarity did not seem to be disrupted by the presence of re-pairing in the phonetic dimension. Phonetic similarity produced facilitation but little interference regardless of previous priming conditions. When phonetic processing was encouraged, however, subjects failed to use semantic information when it became potentially useful. The intra-list interference effects, typically reported with phonetic similarity, were not found in the conditions of this study where inter-list similarity was employed.

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APPENDIX A

Stimulus Materials

SET A

filth	soil	dirt	grime	shirt	flirt	boil
injure	wound	harm	hurt	charm	arm	tuned
plantation	estate	ranch	farm	blanch	stanch	elate
bough	limb	twig	branch	rig	pig	slim
huge	large	great	big	weight	fate	barge
carton	box	case	crate	chase	place	fox
foundation	ground	floor	base	store	door	round
bellow	cry	yell	roar	shell	bell	dry
dungeon	prison	jail	cell	rail	tail	risen
route	road	path	trail	bath	math	load
anger	fury	rage	wrath	page	wage	jury
era	span	time	age	lime	crime	scan

SET B

rock	bank	cliff	crag	stiff	skiff	rank
smell	nose	scent	sniff	tent	rent	hose
nick	crease	cut	dent	nut	gut	grease
cabin	shed	shack	hut	slack	stack	tred
satchel	purse	pouch	sack	couch	grouch	curse
squat	kneel	stoop	crouch	troop	scoop	wheel
circle	disk	ring	hoop	wing	cling	risk
jump	skip	leap	spring	sleep	peep	slip
sob	mourne	cry	weep	lie	pie	bourne
fasten	knot	hitch	tie	ditch	witch	spot
throw	hurl	toss	pitch	moss	loss	girl
bicker	row	nag	box	rag	stag	cow

APPENDIX B

Instructions to Subjects

This experiment is part of a project concerned with paired associate learning. We are interested in how long it takes people to learn lists of words paired with numbers.

You are going to learn three different lists. Each list you learn is composed of twelve different common words. Each word has a number from one to twelve associated with it. We want you to learn which of the twelve possible numbers goes with each word.

For example, if there was the word "baby" in the list, you would be expected to learn what its number is. If the correct number for "baby" was "7", then you would call out "7" when "baby" appeared.

In front of you is a screen with a small box in it. On the window of this box the words are going to be shown. Each of the twelve words will appear one at a time on the screen. However, the numbers one to twelve that go with each word will not appear. You will have to guess for each word what the correct number is. You must say your response out loud while the word is still on the screen. The word will stay on the screen for only a short period of time, so you must make your response quite quickly.

After the word has appeared for this short time, and you have made your guess, the screen will go blank, again for only a short time. During this period you will find out if your answer was correct. If the number you guessed was correct, I will say "yes". If your answer was incorrect, I will say "no". You must try to remember this number because the same word will come up again later on.

After this blank period, another one of the twelve words will appear on the screen. Again you must call out your answer for this new word. Again the word will disappear from the screen, and I will tell you if you were correct.

This procedure will be continued until all twelve words have appeared and you have guessed a number for each one. After all twelve words have appeared and been tested, the screen will go blank and a new trial will begin. The twelve words will again appear one at a time for your responses. They will not appear in the same order as the trial before.

This procedure will be repeated over and over again until you have learned the correct answers for each word well enough, and then the machine will stop.

Now a new list of twelve words will be presented in exactly the same way as before. Again each word has associated with it a number from one through twelve, and you must learn which number now goes with each word. Altogether you will learn three lists in this way with the same twelve numbers as the answers. For example if on List 1 the number "7" was correct for "baby", on the second list the number "7" goes with a new word.

Remember you will never actually see the numbers on the screen. You must guess each time a word appears until you discover the correct answer. For example, let us say the word "baby" appears for the first time, and you say "3". If I say "no", then you know that "3" is wrong. The next time the word "baby" appears, you would try another number.

It is important that you make a response each time a word appears

on the screen, before it disappears. Don't worry about mistakes. Especially for the first few trials you are going to be guessing so you won't be correct very often. The only way you can learn is to keep guessing until you get it right.

FOR P-SPR, P-PR AND P-S ONLY

BEFORE LIST 1

You will find it easier if you concentrate on the ways the words would sound if you pronounced them. Try to connect the sound of the word with its number.

BEFORE LIST 2

I told you to concentrate on the sounds of the words in the previous list. Now you will see why. This next list has 12 new words which sound like those in the first list. For example if on List 1 one of the words was 'THUNDER' and the correct number was '8', on this list one of the words might be 'PLUNDER' and again the correct answer would be '8'. So each word in this list is similar in sound to one of the words from the previous list, and the number that goes with each of these is the same number that went with the similar word before. So, all you have to do when these new words start appearing is to remember which number went with the one before that sounds the same, and call out this number.

BEFORE LIST 3

Now you will learn a third list of 12 new words paired with the same twelve numbers. This time just try to associate each word with its number. Remember to guess when you are not sure.

FOR S-S AND S-SPR ONLY

READ BEFORE LIST 1

You will find it easier to learn this list if you concentrate on the meanings of the words. Try to connect the meaning of each word with its number.

READ FOLLOWING ABOVE BEFORE LIST 2

I told you before the first list to concentrate on the meanings of the words. Now you will see why. This next list has 12 new words which are similar in meaning to those in the first list. For example if on List 1 one of the words was 'BABY' and the correct number was '7', on this list one of the words might be 'INFANT', and again the correct answer would be '7'. So each word on this list is similar to one of the words from the previous list, and the number that goes with each of these is the same number that went with the similar word before. So, all you have to do when these new words start appearing is to remember which number went with the one before that means approximately the same thing, and call out this answer.

READ BEFORE LIST 3

Again, as before these 12 new words will be similar in meaning to the ones before, and again the numbers for each one are the same as they were for the previous similar words.

FOR U-PR AND U-U ONLY

BEFORE LIST 1

Remember to pay attention to each word as it appears, and keep guessing until you get each one right. If you don't guess at first you won't be able to learn the list.

BEFORE LIST 2

Now you will learn another list of 12 new words. The numbers are the same as before. Again, in the beginning you will have to guess.

BEFORE LIST 3

Repeat above.

APPENDIX C

Analysis of Variance

Table 1

Phonetic Conditions List 1

Source	df	Mean Square	F	p
		Anova Mean Total Errors		
Cond	4	1603.86	0.55	>.05
Within	95	2924.57		
		Anova Mean Trials to Criterion		
Cond	4	35.13	0.60	>.05
Within	95	58.77		

CONDITION	MEAN A	MEAN B	MEAN TOTAL	STANDARD ERROR A	STANDARD ERROR B
	DEPENDENT MEASURE: TRIALS TO CRITERION				
P-S	32.9	28.5	30.7	2.0	2.7
P-Pr	29.6	28.9	29.2	1.6	1.6
P-SPr	30.5	34.2	32.3	1.9	3.4
U-U	27.2	32.4	29.8	2.1	3.0
U-Pr	32.1	31.7	31.9	2.4	2.8

Table 2

Phonetic Conditions List 2

Source	df	Mean Square	F	p
Anova Mean Total Errors				
Lists (Cond)	5	829.59	1.25	>.05
Cond	4	28557.73	43.04	<.01
S(L,C)	90	663.58		
Anova Mean Trials to Criterion				
Lists (Cond)	5	72.10	3.11	<.05
Cond	4	430.56	18.58	<.01
S(L,C)	90	23.17		
Anova Mean Errors Trial 1 - Trial 3				
Lists (Cond)	5	60.94	2.94	<.05
Cond	4	2030.33	97.82	<.01
S(L,C)	90	20.76		

Table 2 (cont'd)

CONDITION	MEAN A	MEAN B	MEAN TOTAL	STANDARD ERROR A	STANDARD ERROR B
DEPENDENT MEASURE: TRIALS TO CRITERION					
P-S	12.6	8.0	10.3	1.0	1.3
P-Pr	12.0	9.3	15.6	1.2	1.6
P-SPr	10.2	14.8	12.5	0.9	2.3
U-U	19.7	18.7	19.2	1.3	1.5
U-Pr	22.7	16.8	19.7	2.4	0.4
DEPENDENT MEASURE: ERRORS ON TRIALS 1-3					
P-S	12.2	9.4	10.8	1.3	1.9
P-Pr	14.1	7.5	10.8	1.1	1.7
P-SPr	11.3	13.3	12.3	1.7	2.3
U-U	30.1	28.2	29.1	0.6	0.8
U-Pr	31.3	29.0	30.1	1.1	1.1

Table 3

Phonetic Conditions List 3

Source	df	Mean Square	F	p
		Anova Mean Total Errors		
Lists	1	94.09	0.05	0.83
Cond	4	3559.09	1.86	0.13
Lists x Cond	4	1701.47	0.89	0.47
Residual	90	1915.55		
		Anova Mean Trials to Criterion		
Lists	1	1.44	0.04	0.85
Cond	4	91.64	2.41	0.06
Lists x Cond	4	31.87	0.84	0.50
Residual	90	37.99		
		Anova Mean Errors Trial 1 - Trial 3		
Lists	1	1.96	0.22	0.64
Cond	4	9.76	1.09	0.37
Lists x Cond	4	7.66	0.85	0.50
Residual	90	8.98		

Table 3 (cont'd)

CONDITION	MEAN A	MEAN B	MEAN TOTAL	STANDARD ERROR A	STANDARD ERROR B
DEPENDENT MEASURE: TRIALS TO CRITERION					
P-S	21.4	18.1	19.8	1.5	1.2
P-Pr	21.5	22.3	21.9	1.6	3.4
P-SPr	24.4	22.4	23.4	2.6	1.5
U-U	17.0	20.2	18.6	1.6	2.0
U-Pr	18.5	18.6	18.6	1.8	1.0
DEPENDENT MEASURE: ERRORS ON TRIALS 1-3					
P-S	29.9	30.8	30.4	1.3	1.0
P-Pr	30.0	28.7	29.4	0.8	0.9
P-SPr	31.1	30.6	30.4	1.1	0.9
U-U	29.2	29.6	29.4	0.7	0.8
U-Pr	28.4	30.3	29.4	0.9	1.0

Table 4

Semantic Conditions List 1

Source	df	Mean Square	F	p
		Anova Mean Total Errors		
Cond	3	1555.61	0.56	
Within	76	2800.28		
		Anova Mean Trials to Criterion		
Cond	3	59.25	1.01	
Within	76	58.38		

Table 5

Semantic Conditions List 2

Source	df	Mean Square	F	p
		Anova Mean Total Errors		
Lists (Cond)	4	2216.73	2.67	<.05
Cond	3	24064.75	29.02	<.01
S(L,C)	72	829.16		
		Anova Mean Trials to Criterion		
Lists (Cond)	4	62.82	2.74	<.05
Cond	3	425.08	18.53	<.01
S(L,C)	72	22.94		
		Anova Mean Errors Trial 1 - Trial 3		
Lists (Cond)	4	30.70	1.02	>.05
Cond	3	1162.18	38.51	<.01
S(L,C)	72	30.18		

Table 5 (cont'd)

CONDITION	MEAN A	MEAN B	MEAN TOTAL	STANDARD ERROR A	STANDARD ERROR B
DEPENDENT MEASURE: TRIALS TO CRITERION					
S-SPr	9.1	12.5	10.8	1.2	1.3
S-S	11.5	13.2	12.4	1.4	1.7
U-U	19.7	18.7	19.2	1.3	1.5
U-Pr	22.7	16.8	19.7	2.4	0.4
DEPENDENT MEASURE: ERRORS ON TRIALS 1-3					
S-SPr	13.0	16.9	15.0	2.6	2.5
S-S	18.2	18.7	18.5	2.2	1.5
U-U	30.1	28.2	29.1	0.6	0.8
U-Pr	31.3	29.0	30.1	1.1	1.1

Table 6

Semantic Conditions List 3

Source	df	Mean Square	F	p
		Anova Mean Total Errors		
Lists	1	1611.01	2.33	0.13
Cond	3	46133.88	66.57	0.00
Lists x Cond	3	299.65	0.43	0.73
Residual	72	692.97		
		Anova Mean Trials to Criterion		
Lists	1	76.05	4.19	0.04
Cond	3	952.23	52.40	0.00
Lists x Cond	3	14.68	0.81	0.49
Residual	72	18.17		
		Anova Mean Errors Trial 1 - Trial 3		
Lists	1	140.45	11.15	0.00
Cond	3	3744.82	297.37	0.00
Lists x Cond	3	18.75	1.49	0.23
Residual	72	12.59		

Table 6 (cont'd)

CONDITION	MEAN A	MEAN B	MEAN TOTAL	STANDARD ERROR A	STANDARD ERROR B
DEPENDENT MEASURE: TRIALS TO CRITERION					
S-SPr	4.7	8.3	6.5	0.7	1.2
S-S	6.3	7.2	6.8	1.0	0.8
U-U	17.0	20.2	18.6	1.6	2.0
U-Pr	18.5	18.6	18.6	1.8	1.0
DEPENDENT MEASURE: ERRORS ON TRIALS 1 - 3					
S-SPr	3.1	8.0	5.6	1.2	1.6
S-S	4.1	7.5	5.8	1.2	1.3
U-U	29.2	29.6	29.4	0.7	0.8
U-Pr	28.4	30.3	29.4	0.9	1.0